The uppermost crust of Mars and flood basalts. G. G. Ori[1] and A. Karna[2], [1] Int'l Research School of Planetary Sciences, Univ. d'Annunzio, Viale Pindaro 42, 65127 Pescara, Italy, ggori@irsps.unich.it, [2] Depattment of Astronomy, University of Oulu, Finland.

Introduction: The nature of the uppermost crust of Mars has been deeply discussed since the Viking mission. In recent years, the images of the camera of Mars Global Surveyor have shown that the upper part of the crust is extensively layered [1]. These beds are remarkably exposed in the walls of Valles Marineris [1], but occur also extensively all over the planet. The interpretation is not simple due to the lack of direct observations and unequivocal mineralogical data. However, it is quite probable, that the represent basalt layers accumulated in a way similar to the terrestrial traps [1, 2, 3]. The presence of these flood basalt type units underlying younger ridged-plain materials [1] and veneers of aeolian and other water-laid deposits suggests that the purported impact mega-breccia (mega-regolith) will occur underneath or will be absent. We have carried an extensive analysis of the MOC images investigating the nature of the vertical cliffs forming the rims of craters, the walls of channels and fractures, and other depressions. The data have been located on a planetary map (Figure 1) and correlated to the geological units. In this abstract we will investigate the nature of these layered units at the planetary scale. We will call these stratified formations thick-bedded unit (TBU) to distinguish them from the interior layered deposits and other thin-stratified deposits unrelated with crustal processes. The data set and the interpretation are preliminary and should be regarded as un-reviewed data and working hypothesis.

The nature of the thick-bedded units (TBU): the bedding consists of prominent strata with a medium to dark albedo. These are prominent features that border the upper part of the cliffs. At places, the TBUs display stair-stepped morphologies and benches due to differential erosion. These features occur where the stratification is well developed. In other instances, the poor nature of the outcrops does not allow a detailed definition of the strata that are covered by scree deposits and other kinds of covers. However, these features suggest that the bedding consists of hard lithologies consistent with several rock types including lava flows. In Valles Marineris and in a few other locations, they have been observed along the entire thickness of the cliffs, suggesting that TBU may be as thick as 4 – 5 km. In other cases, they occur only at the top of the cliffs and overlie scree accumulations, at places affected by irregular protruding rock outcrops. In these cases, it is difficult to say if the TBU extend for the entire elevation of the cliffs and are covered in the lower part, or if they rest on top of other units, possibly the megaregolith. The layers are horizontally extensive and some of them have been confidently correlated for several kilometers, suggesting a much wider extension. Clear pinchouts of the beds are rare (Figure 2). Intraformational unconformities have been observed in a couple of cases. Our observations confirm the flood basalt interpretation [1, 2]. The large-scale observation of these beds has ruled out a possible sedimentary origin. Sediments tend to fill basins and swells forming thick sequences related to subsiding areas of the crust.

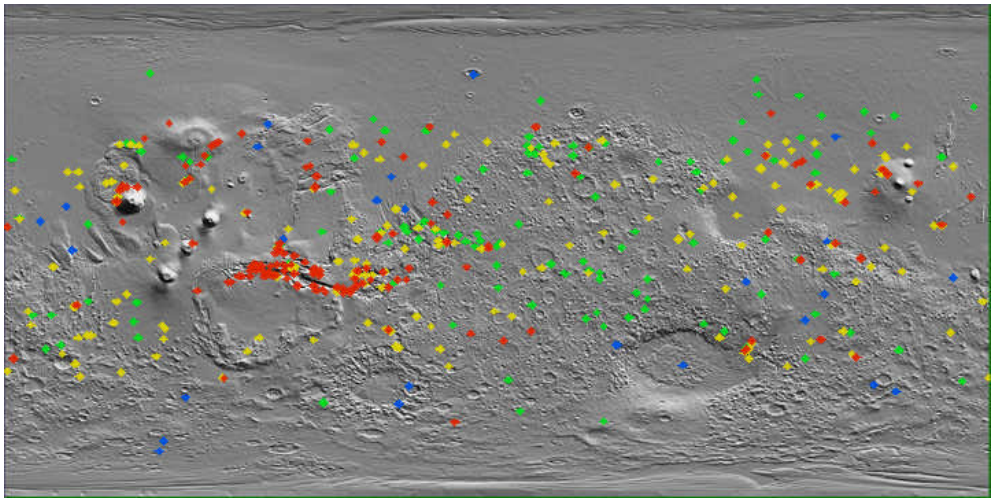

Fig. 1 – Preliminary map with the location of the outcrops. See text for the color code.

There is not evidence of this kind of relation between the TBU and the geological frame. Actually, several of TBU areas are located in elevated zones that, and unless an undetected inversion tectonic, cannot be the sink for sediments.

Geographical analysis: The best examples occur in Valles Marineris [3]. They are clear and remarkably extensive. Crater rims and channel walls in other areas of Mars, however, display fine examples of TBU. We coded our examples in three categories (Figure 1): red, good and clear stratification; yellow, medium to poor developed stratification; green, unclear poor-stratified material. Red and yellow codes suggest the presence of TBU or lava flows linked to volcanic edifices, whereas the green code means that some stratification, is present. Red- and yellow -coded outcrops do not necessarily belong to the TBU because volcano-related stratification is similar to the purported flood basalt sequences (the TBU). We have distinguished the volcanic lava from the flood basalts by means of the morphological settings and some detailed differences in stratification that are at places observable. From the map of Figure 1 it is possible to observe that there are two major areas where TBU are clearly present: the area around Tharsis and Valles Marineris and the area around Elysium. In between these zones, a gap exists of poorly defined outcrops (mostly green code) suggesting the TBU is absent or very thin. Red-coded examples tend to lie on late Noachian to upper Hesperian units. The two main areas of outcrop are related to major volcanoes. This is a feature that has been observed on Earth. We are currently studying an area in East Africa where flood basalt units are affected by younger volcanoes. The volcanic edifices have been emplaced with the flood basalt already inactive. TBU occur mostly in the southern highlands, but some layered units have been observed also in the northern plains. The latter may be linked to the volcanism of Tharsis and Elysium. In the rare instances where stratification is observable in the Northern plains, single beds are thinner than TBU beds and they seem to be arranged in thinner units.

Fig. 2 – Pinchout of a thick bed (M1801089)

Interpretation: Flood basalt events occurred early in the Martian history and probably covered the mega-regolith units formed during earlier stages. It seems that two major traps have present one near Tharsis and the other near Elysium. From these two emission centers lava flows spread covering large part of the planet with a blanket of different thickness. The age is still questionable, but it is possible that these events occurred before the end of the Noachian. Another important open question is the relation between the TBU and the planetary dichotomy.

References:

[1] Malin M. C. et al. (1998) *Science, 279*, 1681–1685. [2] McEwen E. F. et al. (1999) *Nature, 397*, 584-586. [3] Malin M. C. and Edgett K. S. (2001) *JGR, 106*, 23429-23570.

Additional Information: Additional data and the updated and reviewed map will be available in the IRSPS web page: irsps.sci.unich.it